HEAT DISSIPATION INTERFACE FOR SEMICONDUCTOR CHIP STRUCTURES

Field of the invention

The invention is directed to the dissipation of heat in semiconductor chip assemblies and in particular to heat dissipation involving conformable interfaces between the chips and the external ambient.

Background and relation to the prior art

The heat dissipating device which is usually known as the heat sink is commonly used to cool semiconductor chips. However, in usual constructions, such heatsinks have a hard base portion which produces a difficult to cover situation when there are multiple chips, multiple shapes and multiple mountings that in turn may be on a common carrier which may have a variation of spacing, heights and planarity.

There is, therefore, a need to have a heat dissipating interface device that is easy to manufacture while providing a compliant interface between the heat generating device and the transfer to the ambient dissipation device or heat sink. The having of a compliant interface takes on greater importance when the heat dissipation device is shared by several semiconductor devices on a common carrier such as a printed-wiring board.

The advantages of this invention are to provide a low thermal resistance between the heat generating devices and the common heat dissipating device or heat sink through the compliant interface and as the art progresses, it would be of advantage for any heat dissipating device to be modular with it's cooling capacity extendable by stacking and spreading.

There has been some progress in the art. In the IBM Technical Disclosure Bulletin publication, Vol. 34, No. 4A, September 1991, titled "Stacked, Thin Film Heat Sink", describes a method of making a heat sink using thin plates stacked together. In US Patent 6,104,609, titled "Structure Computer Central Processing Unit Heat dissipater", there is described a heat dissipater comprising of a fan, an upper cover, a heat sink assembly, and a lower cover, wherein the heat sink assembly is composed of numerous metal heat sink elements that are interlock-assembled together front to back in a flush arrangement.

Summary of the invention

Heat dissipation in multiple semiconductor chip devices on a common wiring bearing support such as a printed wiring board is achieved through the use of thermally efficient sheets of a material such as metal that are shaped, to permit high density contacting at the printed wiring board interface and to provide support for the use of lower density higher volume transfer, such as the use of heat pipes for continued heat transport in the desired heat transfer. The thermally efficient sheets which may be of metal and called support fins are constructed to be stacked to gain higher cooling capacity and to be spread around to cover multiple chips on a printed-wiring board.

Brief description of the drawings

Figure 1 is a perspective view of a modular portion of a heat dissipation interface structure of the principles of the invention.

Figure 2 illustrates a partially fabricated exemplary shape of a support fin before shaping.

Figures 3a, 3b and 3c, each is a side view of the support fin member of the heat dissipation interface structure of the invention in which the support fin sheets of Fig. 2 are folded and are joined to a wiring pattern on the supporting substrate involving:

in Fig 3a the use of folded metal and thermal grease;

in Fig.3b the use of elastomeric resilience; and,

in Fig. 3c the use of low-melting point solders.

Figure 4 is an illustration of the use of a heat conduction block and heat pipes in connection with the heat dissipation interface in the invention.

Figure 5 is an illustration of the stacking of modular support fin heat pipe heat dissipating interface of the invention.

Figure 6 is an exemplary illustration of the modular fin supporting heat pipe heat dissipating interface device of the invention illustrating the considerations of multiple chips in one planar area.

Description of the invention

As illustrated in Figures 1,2 and 3, in the invention a modular assembly of shaped support fin members is arranged parallel to and with contact to conductors of a wiring bearing area member such as a printed wiring board, a multilayer ceramic module or multiple chips on a supporting board and where the support fin members have a capability to support a heat pipe arrangement. Considering Figures 1,2 and 3 together, Figure 1 is a perspective view of a plurality of support fin members arranged as a modular portion of the heat dissipation interface structure with the principles of the invention; Figure 2 illustrates a partially fabricated sheet before shaping into a support fin; and Figures 3a, 3b and 3c, are each a side view of different embodiments of the support fin component in which the support fin sheets of Fig. 2 are folded and are joined to the wiring pattern on the supporting substrate and attached in Fig 3a using folded metal and thermal grease;in Fig.3b using elastomeric resilience and in Fig.3c using low-melting point solder.

Referring to Figure 1, an assembly 1 of, for the convenience of explanation, six support fin members 2 are shown. The support fin members 2 are formed by folding a piece of a heat conducting material in sheet form of a material such as copper or aluminum metal, or graphite fiber composite, in the thickness range from 0.01 to 5 millimeters. An exemplary shape of the support fin member 2 before folding is shown as element 3 in Fig. 2. After the support fin member 2 is folded into a somewhat inverse U shape 5 in Fig.1, along the fold lines 4 in Fig. 2, a beam-like member 12 in Fig.1, will be inserted between the arms 6 and 7 of the U. The beam-like member 12 is thicker than the sheet material and is made of a heat conducting material such as copper or aluminum.The finger portions 14 at the edges the folded support fin member 2, shown

in Figs 1,2,3a,3b, and 3c are soldered, welded, brazed, or glued to the side walls of the beam-like member 12. The number of the finger portions 14 are not limited to three on each edge as shown in Fig. 2. The extension of the fin member 2 beyond the beam member 12 is then bent to form a contacting support structure as shown in Figs.3 (a,b,& c). These structures become the compliant interface 13 for the modular heat dissipating interface device. The degree of compliance of this interface can further be enhanced by adding some thermally conductive materials such as thermally conductive greases 22 as shown in Fig. 3 (c). The compliant interface can also be enhanced by inserting cylinders 32 made of metal or elastomeric resilient springing materials such as rubber or hollow metal tubes inside as shown in Fig. 3 (b), and as shown in Fig. 3a by adding a low-melting-point solder 42 between the fingers 14 and the beam member 12.

Once the folded-fin members 2 are manufactured, a modular increment of them can be put together as an element 1 as shown in Fig. 1. They can be soldered, spotted welded, or glued togetherand mounted on other heavier heat transport apparatus such as being mounted or screwed on two horizontal bars not shown or assembled with a heat pipe structure. Such a heat pipe structure would involve heat pipes passing through openings 15 and 16 in Fig 1 for transport of the heat accumulated in the beam members 12.

A number of variations such as using conduction blocks, stacking and heat transfer elements for heavier heat transport structures may be employed.

Referring to Figure 4 there is shown an embodiment of the invention involving a separate heat conducting plate.

In the embodiment of Fig 4, the structure at the edges of the support fins is eliminated. A separate heat conducting plate 112 which is made of heat conducting materials such as copper or aluminum is used to provide a compliant interface between a heat generating device which is not shown in the figure and the modular heat dissipating device. As shown in Fig. 4, that is cut away so that the heat conducting plate 112 can be seen. The plate 112 is not mechanically connected to the beam members 12 and is free to move up and down slightly in the cavity formed by the plurality of the beam members 12. Heat collected in the heat conducting plate 112 is passed to the modular heat dissipating device 1 made up a number of joined folded fin members 5 through a plurality of heat pipes 115 and 116. One end of the heat pipe 115 is embedded into the heat conducting plate 112 and the end of heat pipe 116 is mounted or embedded in a plurality of the beam members 12. A spring, which is not shown in the figure, is placed between the top surface of the heat conducting plate 112 and the cut away under the top surface of the folded fin members 5. When the modular heat dissipating device is brought in contact with a heat generating device which is not shown in the figure, the heat conducting plate 112 will be forced to make a good thermal contact to the surface of the heat generating device.

The thermal transport using the heat dissipation principles of the invention are readily employed in stacking structures.

Referring to Figure 5 there is shown two similar modular heat dissipating devices stacked together. When these stacked heat dissipating devices are placed on top of heat generating

semiconductor chips, heat is first conducted through the compliant interface 13 to the fin members 211 and the beam members 212, then to the heat pipes 415 and 416, and then to the beam members 312 and fin members 311.

Cooling media such as air will travel among the fin members 211 and 311 to carry heat away from the heat dissipating device. The fin members in the lower and upper portion of the device are about the same except that the lower portion have the compliant interface 13 and the upper portion does not. The finger portions 314 at the upper fin members 311 are constructed to enhance as much thermal transfer as possible to the traveling cooling media.

The heat transfer principles of the invention readily accommodate the concept of multiple cooling assemblies on the same substrate. Referring to Figure 6 there is shown multiple modular heat dissipating devices n the same substrate. In the figure, there are two modular heat dissipating devices 1 which have similar fin members 511 and 611, placed on and covering in this figure, two separate heat generating semiconductor chips which are mounted on a printed-wiring board 755. A heat pipe 715 is connected between the two modular heat dissipating devices such that heat can be transferred between them. The cooling media 761 is flowing along the fin members 511 and 611 serially. Since the cooling media 761 meets the fin members 611 first, the temperature of this device is generally lower than that of the device with fin members 511 downstream. The heat pipe 715 will carry the heat from the device with fin members 511 back to the device with fin members 611 to even out the temperature difference automatically.

What has been described is a heat transfer principle where heat generated in semiconductor chips is transferred into an assembly of fin supporting members made up of a material such as metal that are arranged, to permit high density contacting at the chip interface and to provide support for the use of higher volume transfer, such as the use of heat pipes for continued heat transport in the desired heat transfer.